PERFORMANCE CHARACTERISTICS OF CI ENGINES USING DIESEL AND BLENDS OF ALMOND OIL BIODIESEL USING SPIRAL SHAPED BLUFF BODIES

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ABSTRACT: The main objective of this attempt is to enhance the air swirl to achieve the better performance characteristics and thermal efficiency of Direct Injection single cylinder diesel engine. To enhance the efficiency of an engine it is important to optimize the thermal efficiency, which is obtained by better air fuel swirling using spiral shaped bluff bodies along with bio diesel almond oil. Spiral shaped bluff bodies is one of the technique to increase the swirling motion on the piston crown to produce high turbulence prior to combustion within the cylinder. Hence the enhancement in the performance of direct injection diesel engine is carried with varying proportions of B10, B20 and B30 blends of biodiesel Almond oil at constant speed and varying loads at 180 bar injection pressure .

Index Terms— Direct injection diesel engines, spiral shaped bluff bodies, performance, almond oil.

1. INTRODUCTION

Direct injection (DI) Diesel engines have an important choice as power source in heavy-duty applications such as industrial, on-road, off-road and marine usage due to their high brake thermal efficiency when compared to petrol engines. They have been a relatively inexpensive and reliable source of power for applications ranging from agricultural use to large scale industrial and transportation applications for most of these years. In diesel engines, a high cetane fuel is injected into the cylinder and mixed with air. The air-fuel mixture thus formed bums due to compression. Though Diesel Engines have many complexities they have gone through very progressive developments over the last century and still improvements taking place. The improved efficiency is caused by the relatively high compression ratios, low pumping losses due to un-throttled mode of operation, the use of lean mixtures, and the fact that crevice volumes have air or products of combustion instead of unburned fuel mixture. Diesel engines produce maximum power output but it is limited due to the emissions.

In this decade it is believed that crude oil and petroleum products will become very scarce and costly. Day to day, fuel economy of engines is getting improved and will continue to improve. However, enormous increase in number of vehicles leads to the demand for fuel. With increased use and the depletion of fossil fuels, alternative fuel technology will become more familiar in the coming decades. One more reason for alternate fuel development is the fact that a large percentage of crude oil must be imported from other countries which control the larger oil fields. All these years there have always been some IC engines fuelled with non-gasoline or diesel oil fuels but their numbers have been relatively very small. Because of high cost of petroleum products, some developing countries are trying to use alternative fuels for vehicles. Another reason is to encourage the development of alternate fuels for the IC engine is the concern over the emission problems of gasoline and diesel engines. Combined with other air-polluting systems, the large number of automobiles is a major contributor to the air quality problem of the world.

2. LITERATURE SURVEY

In DI diesel engines swirl motion is needed for proper mixing of fuel and air. Moreover, the efficiency of diesel engines can be improved by increasing the burning rate of fuel air mixture. This can be achieved in two ways; one by designing the combustion chamber in order to reduce contact between the flame and the surface of the chamber, two by providing the intake system so as to impart a swirl motion for the incoming air. *R.V. Ravi Krishna* [1] studied the effect of swirl by re-entrant piston bowl geometry using Computational Fluid Dynamics (CFD) simulations. This re-entrant chamber produces the higher turbulence in the chamber. *K.Abhilash* [2] investigated on the fabrication of air gap insulated piston is done with different shapes such as conical ,bowl, circular will effect on temperature .V. *Prathibha* [3] investigated that by cutting grooves on the piston crown will affect the swirl for better mixing and hence reduction in brake specific fuel consumption (BSFC). *A.Satya Prasad [*4] reported that Combustion chamber geometry have significance influence on the engine performance, the combustion chamber with the two, three and five grooves on the piston crown will effect on air flow motion in the piston bowl hence there will be improvement in combustion efficiency which is due to formation of homogeneous mixture of fuel with air and greater turbulence in the cylinder. The combustion efficiency in the combustion chamber depends on the formation of mixture of fuel with air. The formation of the homogenous mixture depends on the amount of turbulence created in the combustion chamber.

Venkatesh Babu and Sendilvelan [2008] who had investigated on this work with the orientation of Bluff body. Bluff bodies means the extra material, which is used for the inducement of in-cylinder air swirl motion and increases the turbulence by enhancing the air-fuel mixture by increasing the performance of the engine. *Dr.K.Kalyani Radha and D.Basker* [5] who had investigated on this work .The tests are conducted on piston with bluff body oriented in parallel and perpendicular to the piston pin axis. In regard to the experimental investigation on the performance and emission characteristics of a direct injection diesel engine by using bluff bodies parallel and perpendicular orientations to piston pin axis on high speed diesel fuel gives improved performance with reduced emissions. In the case of bluff body oriented in perpendicular to piston pin axis has the maximum performance when compared with the piston with parallel bluff body and conventional piston. *M. Lakshmi ram naik*[6] who had investigated on the arrangement of a circular shaped threaded rod of 5 mm diameter is placed the piston bowl with vertical position to the

piston pin axis. In regard to this experimental investigation on the performance and emission characteristics of a direct injection diesel engine gives improved performance with reduced emissions when compared to the circular shaped non-threaded rod. The drawback of the circular shaped threaded rod is pitch between the thread is minimum so that motion of the swirl is less. Based on the above reference work further experiment is conducted by some modifications. In the present experiment spiral shaped bluff body is arranged in the piston crown. The 5mm diameter of the spiral shaped rod is inserted in the piston crown at a distance of 12.5mm vertical to the axis and 7mm depth from the top. With the arrangement of the spiral shaped bluff body, when fuel is injected at 180 bar pressure the fuel droplets spread on the rod, due to the shape of the bluff body the fuel moves along the rod in spherical shape leads to the formation of better swirl compared to circular shaped threaded rod due to this performance of engine is improved.

3. EXPERIMENTAL SETUP

The experimental set up consists of an engine, a Dynamometer, top load system, air filter, fuel tank and manometer. A single cylinder vertical type four stroke, water-cooled compression ignition Kirloskar engine is used. The engine is self governed type whose specifications are given in Table 1. This engine can withstand the peak pressures encountered due to its original high compression ratio. Further, the necessary modifications on the piston crown can be easily carried out without change in engine hence this engine is selected for the present project work.

Fig-1: 4-stroke single cylinder kirloskar diesel engine

Engine Specifications:

Table 1: Specifications of the engine

Engine parameters	Specifications (present work)	Specifications (reference work)
Maker	Kirloskar	Kissan
Engine type	Single cylinder four stroke, water cooled, CI engine	Single cylinder four stroke, water cooled, CI engine
Bore	80 mm	85 mm
Stroke	110 mm	110 mm
Speed	1500 rpm	1500 rpm
Rated power	5 HP	5HP
Power output	3.7 KW	3.7 KW

Fuel specifications:

Table 2: Specifications of the Fuel

Properties and standards	Diesel	Almond oil
Density 35^0 C (Kg/m^3)	831	911
Calorific value (KJ/Kg)	42000	41760
Kinematic viscosity (m^2 /sec)	3.82	4.72
Color	Reddish	Yellowish
Flash point(^{0}C)	52	75
Fire point(^{0}C)	65	82

Arrangement of spiral shaped bluff body in piston bowl:

The tests are conducted on the piston with Bluff body oriented perpendicular to the piston pin axis. In this case, a spiral shaped rod of 5 mm diameter is placed in the piston bowl at 7 mm depth from top and at a distance of 12.5mm vertical to the axis is placed on piston bowl as shown in Figure-2.Spiral shape bluff body is to create or induce the air swirl motion inside the engine cylinder. When the fuel is injected the fuel particles flow in spherical motion along the spiral shaped bluff body as shown in fig-3.due to this better mixing of air fuel takes place inside the cylinder. Tests are conducted with diesel and blends of almond oil the enhancement in performance of a direct injection diesel engine is achieved with diesel and blends of almond oil at constant speed and varying loads at 180 bar injection pressure.

The working of spiral shaped bluff body in the piston increases the swirl motion. When the piston approaches the TDC, a portion of the air-fuel mixture is directed on to the spiral bluff body in the piston crown in the form of fluid flow, this fluid flow is passed through the bluff body in the form of high velocity with laminar flow and enters into the lower pressure area of combustion chamber cavity, flow transition is made from

laminar to turbulent with high kinetic energy from the bluff body to the centre of the combustion chamber. The bluff body can allow the flame to propagate through it and enhance, to burn charge completely without any hot spots. By this mechanism, combustion is rapid and complete, resulted in lower build-up of engine operating temperatures, and enhanced torque and power through the range of the engine operation, emitting lower emissions, smoother operation and an increased engine life.

Fig-2: Spiral shaped Bluff body

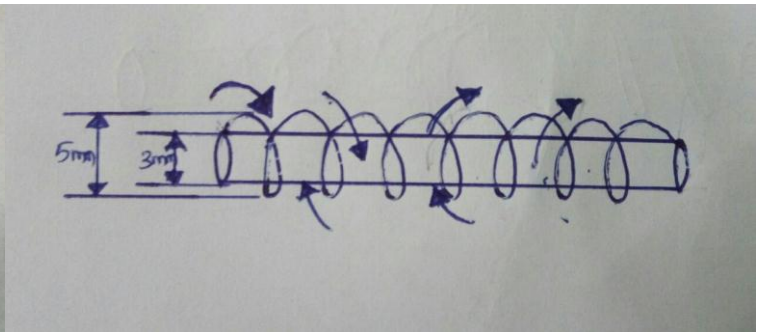
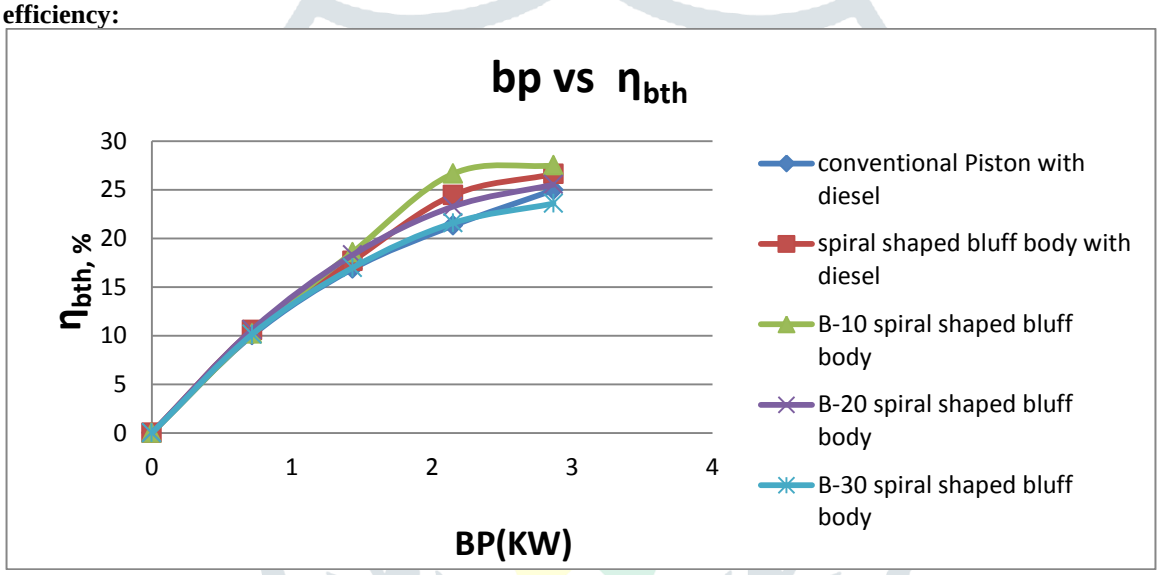


Fig-3: Motion of fuel flow in the bluff body

4. RESULTS AND DISCUSSIONS

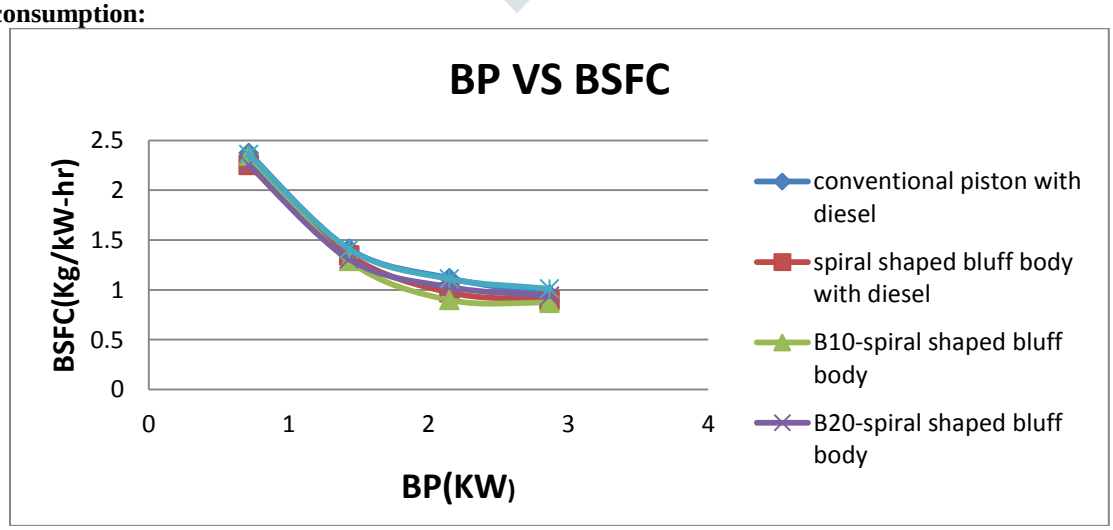
1. Brake thermal efficiency:



Graph-1:brake power vs brake thermal efficiency

Graph-1 is drawn between the brake power and brake thermal efficiency. The thermal efficiency increased by using the spiral shaped bluff body with B10. Thermal efficiency of the bluff body with diesel and B10 are nearly equal to the conventional piston when compared with other blends. Among all the blends, B10 has the highest thermal efficiency at all load conditions, It is observed that the piston with spiral shaped Bluff body gives higher brake thermal efficiency than the conventional piston and other blends, due to the enhanced air swirl in the combustion chamber which resulted in better mixing of air and fuel as well as complete combustion of charge in combustion chamber.

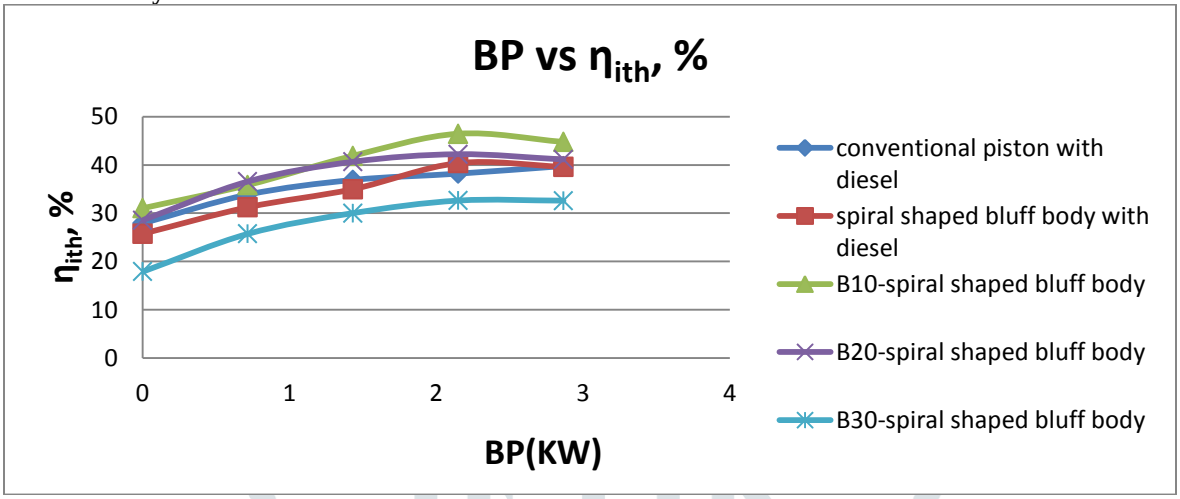
2. Brake specific fuel consumption:



Graph 2: brake power vs brake specific fuel consumption

Graph-2 is drawn between the brake power and brake specific fuel consumption. The effect on specific fuel consumption is varying with different loads at constant speed. The fuel consumption of spherical shaped bluff body is 0.87 Kg/KW-hr and the fuel consumption for convention piston is 0.953 Kg/KW-hr . It is observed that the piston with spiral shaped Bluff bodies has the lowest fuel consumption which is lower than the conventional piston, because of the complete combustion of the charge in the combustion chamber by liberating the maximum energy, due to better calorific value of almond oil.

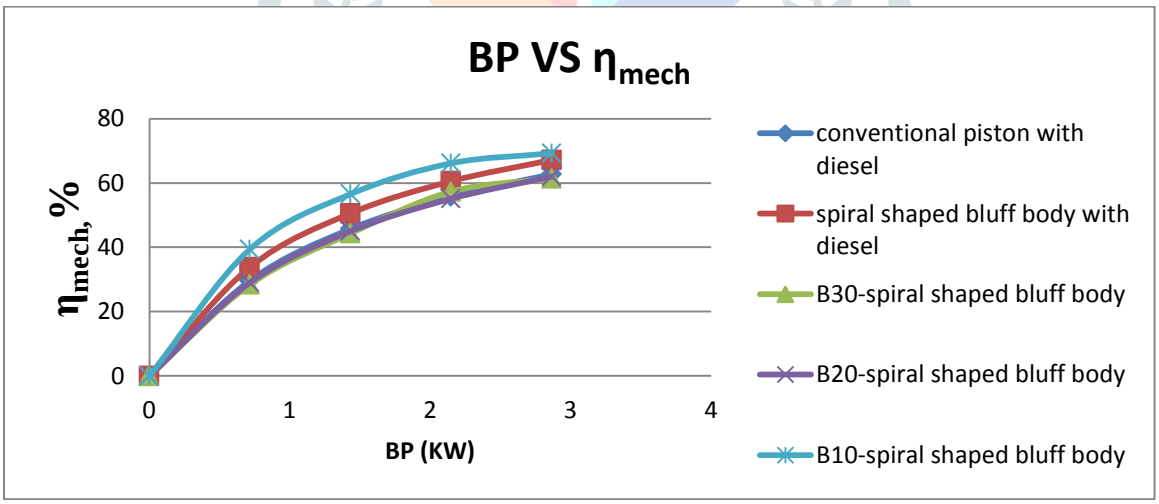
3. Indicated thermal efficiency:



Graph-3: Brake Power vs Indicated Thermal Efficiency

Graph-3 is drawn between the brake power and indicated thermal efficiency. The effect on indicated thermal efficiency is varying with different loads at constant speed. Among these the spiral shaped bluff body piston with B10 and bluff body piston with diesel have the better indicated thermal efficiency when comparing with the conventional piston. . It is also observed that the piston with spiral shaped bluff body has the highest indicated thermal efficiency.

4.Mechanical efficiency:



Graph 4: Brake Power vs Mechanical Efficiency

Graph-4 is drawn between the brake power and mechanical efficiency. Mechanical efficiency is increased due to less frictional power. Among all the spiral shaped bluff body piston with B10 has the highest mechanical efficiency of about 69.26%. It is also observed that the piston with spiral shaped Bluff body wit B30 has the lowest mechanical efficiency.

4. CONCLUSIONS

From the Experimental Results, the following conclusions are drawn:

1. Brake thermal efficiency of engine increases by 2 % when compared to conventional piston with pure diesel and then with B10 has the highest thermal efficiency by 3.4% when compared with the threaded bluff body.
2. Brake Specific fuel consumption decreases by 0.08 Kg/KW-hr when compared to conventional piston with diesel and then with B10 has the lowest specific fuel consumption by 0.1 Kg/KW-hr when comparing with the threaded bluff body and other blends of B20 and B30.

3. The indicated thermal efficiency is higher and mechanical efficiency is higher for B10 and bluff body with diesel when compared with the conventional piston and other blends. The efficiency of the engine will be increased due to air swirl motion inside the chamber which results the better mixing of air and fuel and also complete combustion inside the chamber.

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